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**SQM-160**

**Rate/Thickness Monitor**

**User's Guide**

**Version 2.0**

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**S** **Sigma**  
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## **Safety Information**

Read this manual before installing, operating, or servicing this equipment. Do not install substitute parts, or perform any unauthorized modification of the product. Return the product to Sigma Instruments for service and repair to ensure that safety features are maintained.

## **Safety Symbols**

**WARNING:** Calls attention to a procedure, practice, or condition, that could possibly cause bodily injury or death.

**CAUTION:** Calls attention to a procedure, practice, or condition, that could possibly cause damage to equipment or permanent loss of data.



Refer to manual for specific Warning or Caution information to avoid personal injury or equipment damage.



Hazardous voltages may be present.



Earth ground symbol.



Chassis ground symbol.

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## **Warranty Information**

This Sigma Instruments product is warranted against defects in material and workmanship for a period of 1 year from the date of shipment, when used in accordance with the instructions in this manual. During the warranty period, Sigma Instruments will, at its option, either repair or replace products that prove to be defective.

## **Limitation of Warranty**

Defects from, or repairs necessitated by, misuse or alteration of the product, or any cause other than defective materials or workmanship are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. UNDER NO CIRCUMSTANCES SHALL SIGMA INSTRUMENTS BE LIABLE FOR CONSEQUENTIAL OR OTHER DAMAGES RESULTING FROM A BREACH OF THIS LIMITED WARRANTY, OR OTHERWISE.

## **Return Policy**

The purchaser may return this product in like new condition within 30 days after shipment for any reason. In case of return, purchaser is liable and responsible for all freight charges in both directions.

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## 1.0 Introduction

Congratulations on your purchase of the SQM-160 Deposition Rate/Thickness Monitor. The SQM-160 is an easy-to-use instrument for measuring many types of thin film coatings. This chapter will help to get you up and running quickly. Please review the entire manual for detailed operational, programming, and safety information.

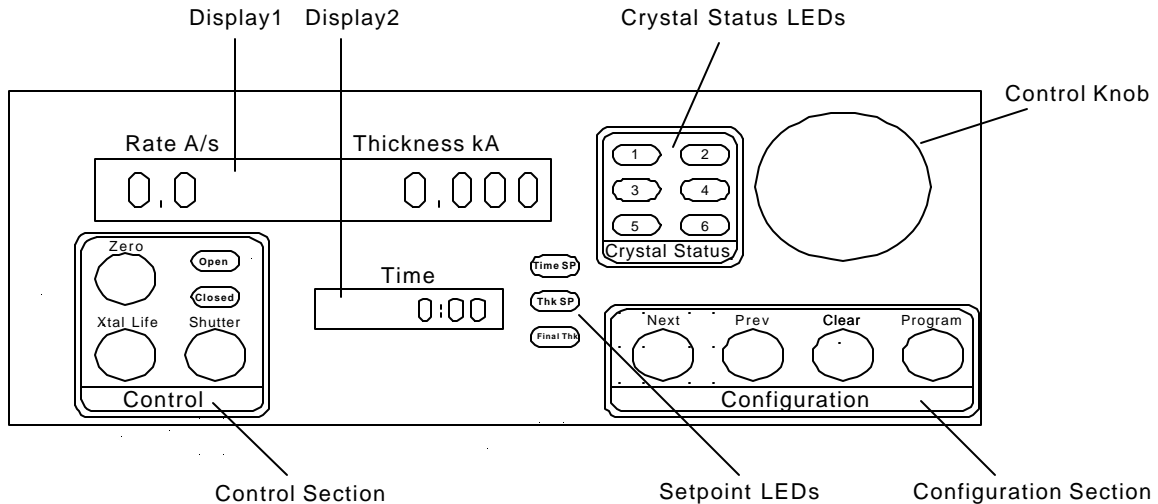
## 1.1 Installation

Refer to Sections 1.3 and 1.4 for detailed system hookup information.

Rack Installation	The SQM-160 occupies a 3.5" high, half-rack space. An optional kit (900-008) is available to adapt to a full rack. Install the unit in a 19" rack with the supplied hardware.
Power Connection	<p><b><u>WARNING:</u></b> The SQM-160 is shipped with a ½ A Fuse for use with 90–120 VAC. If your line voltage is 180–240 VAC, replace the fuse with the ¼A fuse included with your SQM-160.</p> <p><b><u>WARNING:</u></b> Verify that the Voltage Selector Switch located next to the power switch matches your line voltage.</p> <p>Plug the SQM-160 into your power source with the included power cord.</p>
Sensor Connections	Connect the BNC cables and oscillator from your vacuum chamber feedthrough to the desired SQM-160 Sensor Input(s).
Digital I/O Connections	Refer to Appendix C for details on wiring digital I/O to the SQM-160 Relay I/O connector.
Computer Connection	If you would like to use the supplied Windows software to collect data or program the SQM-160, attach a 9 pin straight-thru cable from the SQM-160 RS-232 connector to your computer's serial port.
Option Connections	If you purchased the Analog Output Option (502-021), connect a BNC cable from the Rate or Thickness connector to your chart recorder.

Move the rear panel power switch to the On (I) position. The SQM-160 will briefly display its software version, then go to normal operating mode.

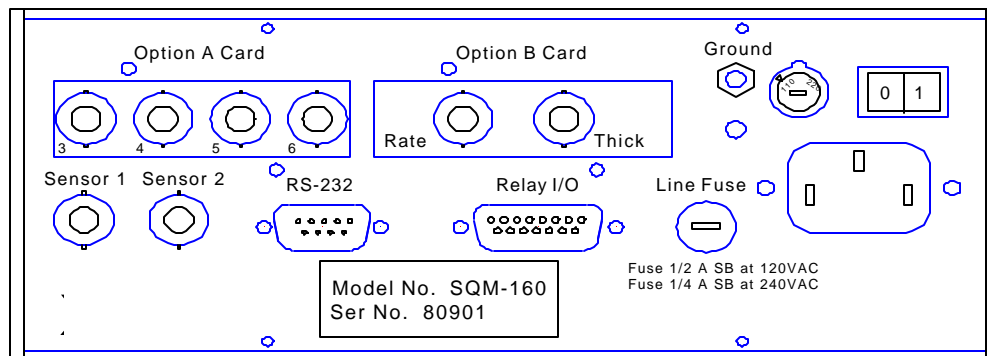
## 1.2 Front Panel




### Front Panel Controls

Display 1	Displays rate and thickness in normal operation. Displays setup parameter name in program mode.
Display 2	Displays deposition time in normal operation. Displays setup parameter value in program mode.
Control Section	Zero thickness reading. Toggle Display 1 between Crystal Life and Rate/Thickness readings. Toggle shutter relay on/off.
Configuration Section	Program enters setup mode. Next/Prev moves thru menus. Clear cancels change and returns value to its original setting.
Setpoint LEDs	Illuminate when the indicated setpoint is reached.
Crystal Status LEDs	Illuminate when a crystal is active and operating. Flashes when an active crystal fails.
Control Knob	Used to adjust values or scroll though menu selections. Pushing the control knob stores the current setting.

### 1.3 Rear Panel



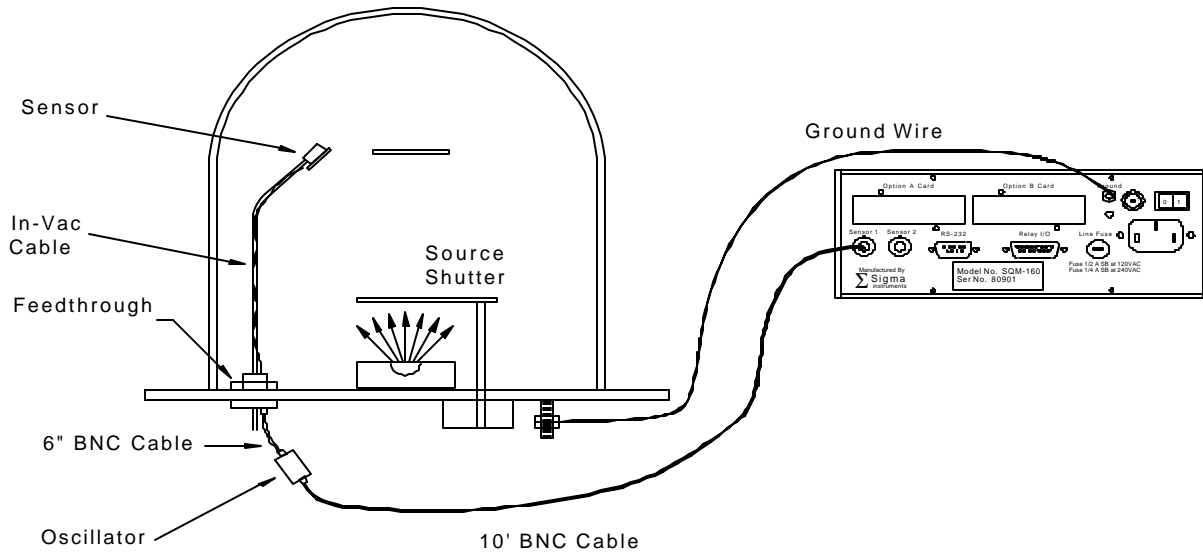
#### Rear Panel Connections

Sensor 1 & 2	Connection to quartz crystal sensor remote oscillator. See Section 1.4 for detailed hookup.
RS-232	Connection to computer serial port for programming and data acquisition.
Relay I/O	Connects 4 relays and 4 digital inputs to external equipment for process control. See Appendix C for connections.
Option A Card	Provides an additional four sensor measurement channels.
Option B Card	Provides two 0-5V analog outputs for rate and thickness readings.
Ground Terminal	 Measurement ground terminal.
Voltage Selector	<b><u>WARNING:</u></b> Select 115V for 90-120VAC, 230V for 180-240VAC.
Line Fuse	<b><u>WARNING:</u></b> Replace line fuse only with a fuse of the specified type and rating.
Power Connector	<b><u>WARNING:</u></b> Use removable power cords only of the specified type and rating.



## 1.4 System Connections

The diagram and table below identifies typical vacuum system components and their function.



### System Components

Sensor	Holds the quartz crystal used to measure rate and thickness. Crystals must be replaced occasionally.
In-Vac Cable	A coax cable, typically 30" long, that connects the sensor to the feedthrough.
Feedthrough	Provides isolation between vacuum and atmosphere for electrical and cooling lines.
6" BNC Cable	Provides a flexible connection from the feedthrough to the oscillator. Keep this cable as short as possible.
Oscillator	Contains the electronics to operate the quartz crystal. Total cable length to the crystal should be under 40".
10' BNC Cable	Connects the oscillator to the SGM-160. Lengths up to 100' are acceptable.
Ground Wire	A wire, typically braided, that connects the vacuum system to the SGM160 ground terminal.

## 1.5 Film Setup

This section will help you setup the SQM-160 to measure a film. Refer to Chapter 2 for detailed film programming instructions.

*Note: User actions with front panel controls are indicated by a Box. Results shown on displays, are indicated by a Dashed Box.*

Enter Program Mode	If the Crystal Life display is shown, press <span style="border: 1px solid black; padding: 0 2px;">Xtal Life</span> to return to Rate/Thickness mode. Press <span style="border: 1px solid black; padding: 0 2px;">Program</span> to enter the film setup menu. Pressing the program switch while in program mode returns the SQM-160 to normal mode.
Select a Film	Turn the <span style="border: 1px solid black; padding: 0 2px;">Control Knob</span> to select one of the nine possible films, then press the <span style="border: 1px solid black; padding: 0 2px;">Control Knob</span> to enter the film parameters menu.
Set Film Parameters	Turn the <span style="border: 1px solid black; padding: 0 2px;">Control Knob</span> to set the first film parameter (density). The parameter value is shown in <span style="border: 1px dashed black; padding: 0 2px;">Display 2</span> . Press the Control Knob to save the value and move to the next film parameter. If you press <span style="border: 1px solid black; padding: 0 2px;">Clear</span> , the film parameter returns to its original value. Continue to set each parameter. When the last film parameter is entered, the SQM-160 returns to normal mode. See Chapter 2 for detailed instructions on setting Film Parameters.
Set System Parameters	To Enter the system menu, press <span style="border: 1px solid black; padding: 0 2px;">Program</span> , then <span style="border: 1px solid black; padding: 0 2px;">Prev</span> . Set system parameters by turning, then pushing, the <span style="border: 1px solid black; padding: 0 2px;">Control Knob</span> as described above. See Chapter 2 for detailed instructions on setting System Parameters.

If the sensor(s) you selected during film setup are connected to the SQM-160, the Crystal Status LEDs should be lit. If not, return to the Film Parameters menu and set the Sensor Average parameter to the desired sensor(s).

If the Crystal Status LED is flashing, it is most likely that sensor is not properly connected. Sigma supplies a small test crystal with each oscillator module that can be used to test sensor connections external to the vacuum chamber. Referring to Section 1.4, disconnect the oscillator from its 6" BNC cable. Attach the test crystal to the oscillator's feedthrough connector. The Crystal Status LED will remain lit if the external sensor connections are correct.

Refer to the Sensor Selection, Frequency Display and Sensor Min/Max sections of Chapter 2 for information that can assist in troubleshooting sensor problems.

## 1.6 Depositing a Film

If you have followed this Quick Start chapter, you are ready to deposit a film. Follow the procedure below to begin deposition.

Verify Sensor Operation	Verify that the Crystal Status LED for the measuring sensor is lit, and not flashing.
Display Rate/Thickness	<b>Display 1</b> should be displaying Rate on the left and Thickness on the right. If the Crystal Life display mode is active, press the <b>Xtal Life</b> switch to return to Rate/Thickness mode. If the Program Mode is active, press <b>Program</b> to return to normal mode.
Zero Thickness	If needed, press the Zero switch to zero the thickness reading.
Start Deposition	Apply power to your source evaporation supply. If the SQM-160 shutter relay is connected, press the Shutter switch to begin deposition.

The Rate and Thickness displays should begin to move from zero. Please take time to review the remainder of this manual for detailed operational, programming, and safety information.

If the displays remain at zero, check your system setup to assure that you are actually evaporating. Also check that the deposited material is reaching the sensor.

If the display is erratic or noisy, first check your sensor connections. Refer to the Timebase, Rate Filter and Rate Resolution sections of Chapter 2 for information that can help in troubleshooting noisy reading problems.

If the rate and thickness readings do not match your expectations, refer to the Film Parameter (Density, Z-Factor, Tooling) and Sensor Tooling sections of Chapter 2.

## 2.0 Introduction

This section details the operation of the SQM-160 menus and front panel controls. It is arranged by common user tasks.

*Note: User actions with front panel controls are indicated by a **Box**. Results shown on displays, are indicated by a **Dashed Box**.*

## 2.1 Menu Selection

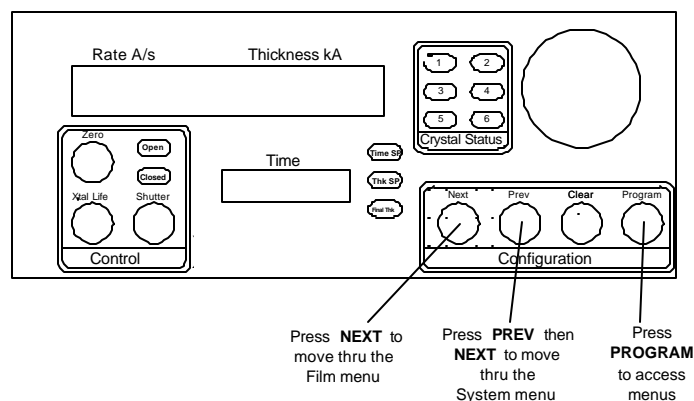
Two menus provide control of the SQM-160 programming. The Film Parameters Menu allows you to customize each of the nine stored films. The System Parameters Menu sets values that remain constant for **all** films.

*Note: If Crystal Life is shown on the SQM-160 displays, press the Xtal Life switch to return the displays to rate/thickness or frequency display.*

The Configuration Section of the SQM-160 front panel contains four switches used to access the program menus. Within the program menu, the **Control Knob** is also used to adjust values and select menu choices. In program mode, **Display 1** shows the parameter to be changed. **Display 2** shows the selected parameter's value.

To enter the Film Parameters Menu, press the **Program** switch. The SQM-160 displays the currently active film. Turn the control knob to select a different film, then press **Next** to display the first parameter for the selected film.

To enter the System Parameters Menu, press the **Program** switch. Then press **Prev** to display the first system parameter.



## 2.2 Film Parameters Setup

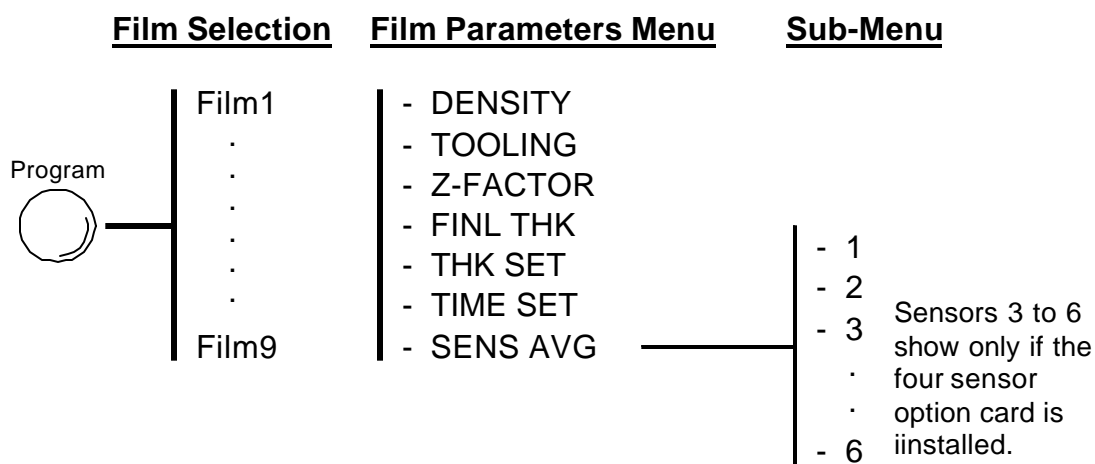
The Film Parameters Menu programs the SQM-160 for the materials that will be deposited as thin films. Nine films can be stored, but only one film is active at any time. To program film parameters:

1. Press **Program** to enter program mode.
2. Use the **Control Knob** to scroll to the desired Film # (1-9).
3. Depress the **Control Knob** or **Next** to enter the film parameters menu for the selected film.
4. Use **Next** and **Prev** to move through the film parameters, shown in **Display 1**.
5. Use the **Control Knob** to adjust the parameter value, shown in **Display2**, to the desired setting.
6. Press **Clear** to abandon the change and return to the original setting.
7. Depress the **Control Knob** to save the displayed value, or press **Next** to exit without saving the value. (Pressing either one will take you to the next material parameter.)
8. Press **Program** to exit the Film Parameters Menu and return to normal mode.

Notes:

1. Refer to the section on Sensor Selection for instructions on setting **SENS AVG**.
2. A setting of zero for **FINL THK**, **THK SET** or **TIME SET** will disable that function.

The diagram and table below detail the parameters available in the Film Parameters Menu:



<u>Display</u>	<u>Description</u>	<u>Range</u>	<u>Default</u>	<u>Units</u>
<b>DENSITY</b>	Density of the material being deposited.	0.5 – 99.99	1.00	gm/cc
<b>TOOLING</b>	Overall tooling Factor for this film. See the <u>Sensor Tooling</u> section of this chapter for information on setting tooling values.	10 – 399	100	%
<b>Z-FACTOR</b>	Z-Factor of the material being deposited.	0.10 – 10.00	1.0	
<b>FINL THK</b>	Desired Final Thickness of deposited material. Lights Final Thk LED. Zero is disabled.	0.000 – 99.99	0.500	KÅ
<b>THK SET</b>	Thickness value that closes the Thickness Setpoint relay and lights Thk SP LED. Zero is disabled.	0.000 – 99.99	0	KÅ
<b>TIME SET</b>	Elapsed time that closes the Timer Setpoint relay and lights Time SP LED. Zero is disabled.	0:00 – 99:59	0	Sec
<b>SENS AVG</b>	Enable/disable crystals for this film. See the <u>Sensor Selection</u> section of this chapter for more information.	Enabled/ Disabled	Ch1 Enabled	

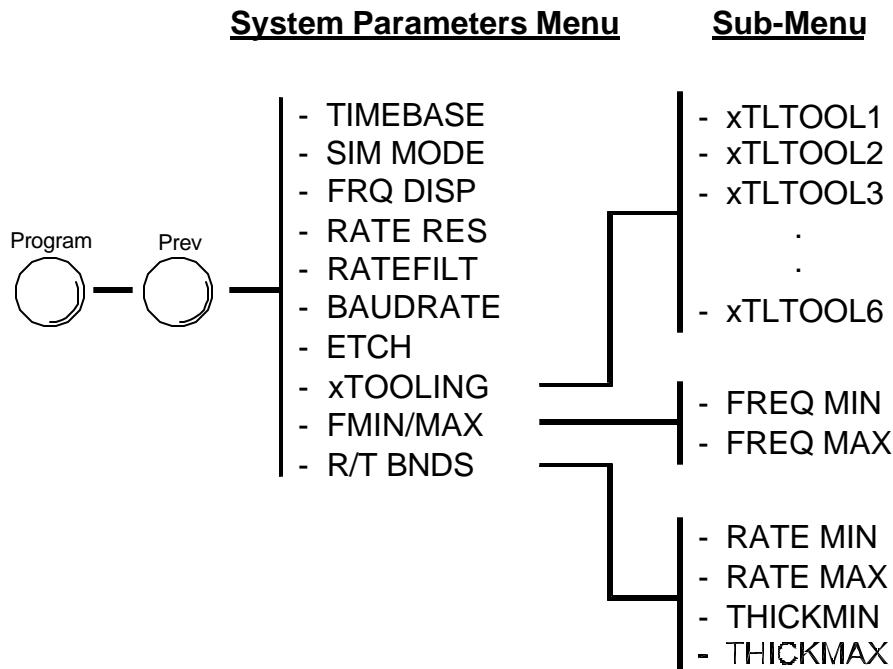
## 2.3 System Parameters Setup

The System Parameters Menu sets values that pertain to the overall functioning of the SQM-160, and to your vacuum system's setup. System parameters are constant for **all** films.

1. Press **Program** to enter program mode.
2. Press **Prev** to enter the System Parameters Menu
3. Use **Next** and **Prev** to move through the system parameters.
4. Use the **Control Knob** to adjust the parameter value shown in **Display2** to the desired setting.
5. Press **Clear** to abandon the change and return to the original setting.
6. Depress the Control Knob to save the displayed value, or press **Next** to exit without saving the value. (Pressing either one will take you to the next material parameter.)
7. Press **Program** to exit the System Parameters Menu and return to normal mode.

*Notes:*

1. Refer to the section on *Sensor Tooling* for instructions on setting **xTOOLING**.
2. Refer to the section on *Sensor Min/Max* for instructions on setting **FMIN/FMAX**.
3. Refer to the *Options Chapter* for instructions on setting *R/T BNDS* for the Analog Output Card



<u>Display</u>	<u>Description</u>	<u>Range</u>	<u>Default</u>	<u>Units</u>
<b>TIMEBASE</b>	Time required to take a single measurement	0.15 – 2.00	0.25	sec
<b>SIM MODE</b>	Simulates sensors.	On/Off	Off	
<b>FRQ DISP</b>	Toggles between Rate/Thickness and Frequency Displays	On/Off	Off	
<b>RATE RES</b>	Display resolution of Rate	Hi/Low	Low	
<b>RATEFILT</b>	Number of readings averaged for rate calculations	1 – 20	8	
<b>BAUDRATE</b>	Serial Baud Rate to PC	2.4 – 19.2	19.2	kbps
<b>ETCH</b>	Sets mode to negative rate for etching applications	On/Off	Off	



<u>Display</u>	<u>Description</u>	<u>Range</u>	<u>Default</u>	<u>Units</u>
<b>xTOOLING</b>	Tooling value assigned to each sensor. See the <u>Sensor Tooling</u> section of this chapter for information on setting tooling values.	10 – 399	100	%
<b>FMIN/MAX</b>	Sub-Menu to select Crystal Frequency Limits			
<b>FREQ MIN</b>	Minimum Crystal Frequency	4.00 – 6.00	5.00	MHz
<b>FREQ MAX</b>	Maximum Crystal Frequency	4.10 – 6.10	6.10	MHz

The following System Parameters apply only if the optional Analog Output card is installed. See the Options chapter for more information on setting the Analog Output Card parameters.

<u>Display</u>	<u>Description</u>	<u>Range</u>	<u>Default</u>	<u>Units</u>
<b>R/T BNDS</b>	Rate and Thickness Bounds Sub-Menu			
<b>RATE MIN</b>	Deposition Rate for Zero Output (Zero Volts)	0 – 999	0	Å/s
<b>RATE MAX</b>	Deposition Rate for Full Scale Output (+5 Volts)	9.9 – 999	100	Å/s
<b>THICKMIN</b>	Thickness for Zero Output (Zero Volts)	0 – 99.99	0.00	kÅ
<b>THICKMAX</b>	Thickness for Full Scale Output (+5 Volts)	0 – 99.99	1.00	kÅ

## 2.4 Sensor Selection

The SQM-160 comes standard with two sensor inputs. Four additional sensors are available by adding a Sensor Option Card. The sensors can each be assigned to a different film, or multiple sensors can be averaged for a single film. The averaging option provides more uniform coverage of the deposition area, and provides a backup sensor capability. If one of multiple sensors assigned to a film fails, the sensor is automatically removed from rate/thickness calculations.

To assign a sensor, or sensors, to a film:

1. Press **Program** to enter program mode.
2. Use the **Control Knob** to scroll to the desired Film # (1-9).
3. Depress the **Control Knob** or **Next** to enter the film parameters menu for the selected film.
4. Press **Next** until **SENS AVG** is shown.
5. Use the **Control Knob** to scroll through the sensors in **Display2**.
6. Depress the **Control Knob** to toggle the sensor on/off.

*Sensor status can be seen by observing the Crystal Status LEDs:*

*If the LED is not illuminated, the crystal is disabled.*

*If the LED is illuminated, the crystal is enabled and receiving valid readings.*

*If the LED is flashing, the crystal is enabled, but is not receiving valid readings.*

7. Continue selecting sensors until the Crystal Status LEDs indicate the desired setup.
8. Press **Program** to exit the Film Parameters Menu and return to normal mode.

## 2.5 Sensor Min/Max Frequency

The Sensor Min/Max frequencies establish the operating range for the sensing quartz crystals. Both values are used to determine the % life that is displayed in Xtal Life mode.

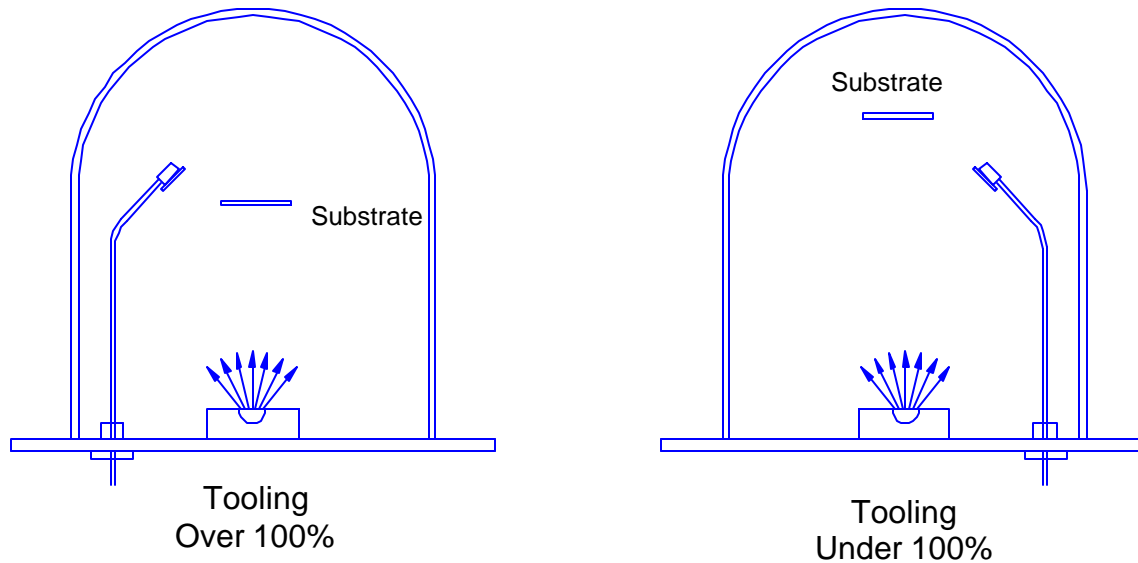
When the sensor frequency drops below the minimum, the SQM-160 indicates a sensor failure by blinking the Crystal Status display. Likewise, a sensor whose initial value exceeds the maximum will cause a blinking Crystal Status.

To set sensor minimum and maximum frequencies:

1. Press **Program** to enter program mode.
2. Press **Prev** to enter the System Parameters Menu
3. Press **Next** until **FMIN/FMAX** is shown.
4. Depress the **Control Knob** to display **FREQ MIN**.
5. Adjust the **Control Knob** to the desired minimum operating frequency on **Display2**.
6. Depress the **Control Knob** to accept the minimum value and display **FREQ MAX**.
7. Adjust the **Control Knob** to the desired maximum operating frequency on **Display2**.
8. Depress the **Control Knob** to accept the maximum value.
9. Press **Program** to exit the System Parameters Menu and return to normal mode.

## 2.6 Sensor Tooling

Sensor Tooling adjusts for the difference in deposition rate between the sensor and the substrate being coated. It is an empirically determined value that matches the sensor readings to your vacuum system.



The first Tooling is set in the Film Parameters Menu and is applied to the averaged Rate and Thickness for all sensors assigned to that film. Film Tooling is a film specific value.

The second Tooling Factor, xTooling, is set in the System Parameters menu. It adjusts the tooling for each individual sensor before it is averaged. xTooling for a sensor applies to all films. If the individual sensor xToolings are set properly, a sensor failure will not cause a jump in the average Rate and Thickness reading.

To adjust xTooling:

1. Press **Program** to enter program mode.
2. Press **Prev** to enter the System Parameters Menu
3. Press **Next** until **FRQ DISP** is shown, then press the **Control Knob**.
4. Adjust the **Control Knob** to set the **XTLTOOL 1** value
5. Depress the **Control Knob** to save the value and move to **XTALTOOL 2**.
6. Repeat Steps 4-5 for each of the installed sensors.
7. Press **Program** to exit the System Parameters Menu and return to normal mode.

## 2.7 Rate/Thickness or Frequency Display

The SQM-160 determines deposition rate and thickness by measuring the frequency shift of a crystal oscillator over time. In some applications, the actual crystal frequency is desired. *Displaying crystal frequency can also be useful in troubleshooting sensor operation.*

To select Rate/Thickness, or Frequency displays:

1. Press **Program** to enter program mode.
2. Press **Prev** to enter the System Parameters Menu
3. Press **Next** until **FRQ DISP** is shown.
4. Turn the **Control Knob** left or right to select the desired display mode.
5. Depress the **Control Knob** to accept the value.
6. Press **Program** to exit the System Parameters Menu and return to normal mode.

## 2.8 Crystal Life Display

The SQM-160 calculates the remaining crystal life based on the FMin/Max values set in the System Parameters Menu (see Section 2.5).

To display the remaining crystal life for the sensors used by the currently active film:

1. Press the **Xtal Life** switch in the front panel Control section.
2. The sensor is shown in **Display 1**, the % remaining life, is shown in **Display2**.
3. Turn the **Control Knob** to display the % life of other sensors active for this film.
4. Press **Xtal Life** to return to normal rate/thickness, or frequency display.

*Note: You cannot enter program mode while the crystal life display is active.*

## 2.9 Zero Thickness

Before starting each film deposition, you will probably want to reset the SQM-160 Thickness value to zero. To zero Thickness:

1. Press the **Zero** switch in the front panel Control section.

*In addition to zeroing Thickness, pressing the Zero switch has these effects:*

1. *The Time display is reset to its programmed value, and starts counting down.*
2. *The Thickness Setpoint and Timer relays open.*
3. *The Time SP, Thk SP, and Final Thk LEDs turn off.*

## 2.10 Shutter Operation

The SQM-160 Shutter Relay normally controls the source material shutter. To open or close the Shutter Relay:

1. Press the **Shutter** switch in the front panel Control section.

*The Open and Closed LEDs light to indicate the Shutter relay status.*

## 2.11 Simulate Mode

In Simulate Mode, the SQM-160 simulates attached sensors. It is an easy way to become familiar with the SQM-160 front panel controls and programming. In Simulate Mode you can open/close the shutter to simulate deposition, zero readings, and display crystal life. You can also test the Time and Thickness setpoint relays and LEDs.

To enter Simulate Mode:

1. Press **Program** to enter program mode.
2. Press **Prev** to enter the System Parameters Menu
3. Press **Next** until **SIM MODE** is shown.
4. Turn the **Control Knob** left or right to enable and disable Simulate Mode.
5. Depress the **Control Knob** to accept the value.
6. Press **Program** to exit the System Parameters Menu and return to normal mode.

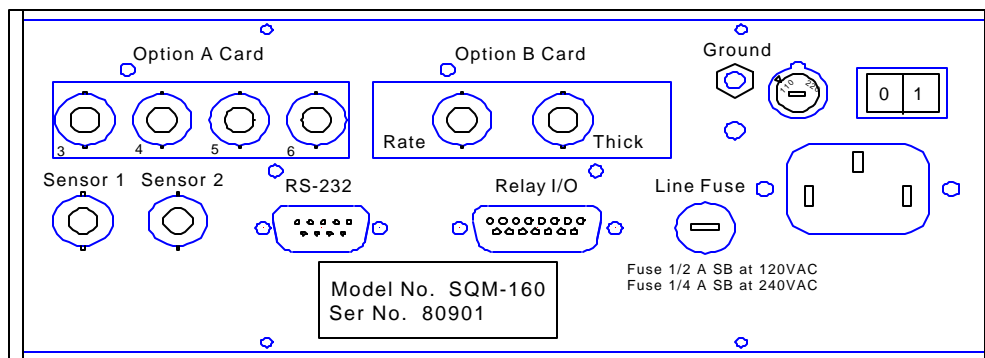
### 3.0 Introduction

The SQM-160 has two slots to accommodate option cards. The Option A slot holds a Four Sensor Card, which expands the SQM-160 inputs to a total of six quartz crystal sensors. The Option B Analog Output Card provides Rate and Thickness outputs for connection to strip chart recorders.

### 3.1 Installation



**WARNING:** Hazardous voltages are present inside the SQM-160 when it is connected to a power source. Remove the power cable before opening the case to install option cards.



Remove  
Top Cover.

Use a 1/16" hex driver to remove the four screws that attach the top cover to the chassis. Remove the top cover.

Remove Option  
Cover Plate

Use a 1/16" hex driver to remove the two 4-40 back panel screws that hold the option cover plate. Save the screws. Remove the option cover plate.

Insert  
Option Card

Insert the option card, from the inside, through the rear panel opening. Option A slot is for the Four Sensor Card, Option B slot is the Analog Output Card. Align the 36-pin option card connector with the mating pins on the main board. Press the option card connector onto the main board pins.

Secure  
Option Card

Secure the option card to the rear panel with the screws saved in Step 2, and to the main board with the supplied 4-40 screw.

Replace Top  
Cover

Replace the top cover, and attach it to the chassis with the four screws from Step 1.

### 3.2 Four Sensor Card

The SQM-160 automatically detects the presence of the Four Sensor Card.

Refer to System Connections in Chapter 1 for sensor hookup information.

Refer to Chapter 2, Sensor Selection, to assign Four Sensor Card sensors to a film.

### 3.3 Analog Output Card

Once the Analog Output Card is installed, the SQM-160 System Parameters must be set to match the device that will be attached to the Rate or Thickness output.

To setup the Analog Output Card in the System Parameters menu:

1. Press **Program** to enter program mode.
2. Press **Prev** to enter the System Parameters Menu
3. Use **Next** to move through the system parameters until **R/T BNDS** is displayed.
4. Depress the **Control Knob** to display **RATE MIN**.
5. Adjust the **Control Knob** to the Rate desired for a 0V output.
6. Depress the **Control Knob** to save the value and display the **RATE MAX** setting.
7. Adjust the **Control Knob** to the Rate desired for a 5V output.
8. Repeat steps 4-7 to adjust the Thickness output values.
9. Press **Program** to exit the System Parameters Menu and return to normal mode.

Refer to System Parameters Setup in Chapter 2 for more information on setting SQM-160 System Parameters.



## 4.0 Introduction

Included with the SQM-160 is a Windows 95/98 program, MonComm. MonComm is used to setup instrument parameters, graph, and save instrument readings.

## 4.1 Installation

1. Insert installation Disk 1 into your computer's A Drive.
2. In Windows 95/98 select Start, then Run. Type A:\Setup, then click OK.
3. Follow the on-screen instructions to complete the installation.

## 4.2 Run MonComm

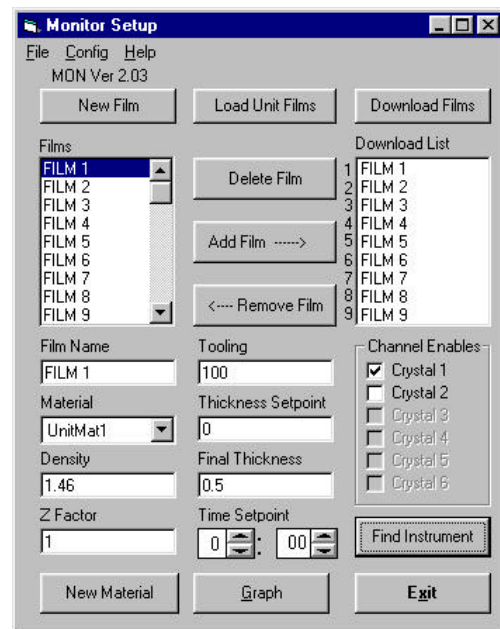
Before starting the MonComm program, connect the SQM-160 to your computer with the straight-thru DB-9 cable supplied.

In Windows 95/98 select Start, Programs, MonComm 1.0, MonComm to start the program.

The main MonComm screen will appear. If the SQM-160 was located by the program, MON Ver X.XX will appear below the menu.

If "No Instrument Found" appears instead, check your connections, and click Find Instrument to try again.

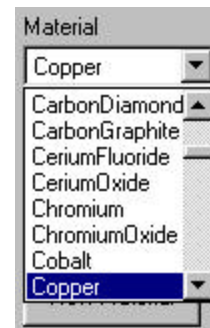
At this point, the download list displays the last films downloaded to the SQM-160. To display the setup currently stored in the SQM-160, click **Load Unit Films**. The Download list is updated with the SQM-160 films.



### 4.3 Add and Delete Films

To add a new film to the Films List:

1. Click the **New Film** button.
2. A film named NewFilm# will be added to the end of the films list.
3. Click on this film to highlight it.
4. Change the name of the film - up to eight characters are allowed.
5. Select the material for the film from the *Material* combo box.
6. The density and the Z-factor for the material will be automatically changed to that of selected material. Both parameters can be edited if desired.
7. Change the tooling for the film to the desired percentage.

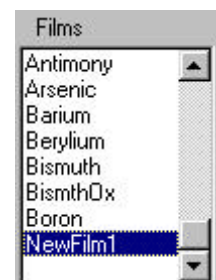


8. Set the thickness setpoint, final thickness, and the time setpoint to the desired values for the film.
9. Select the channels to enable for the film. A checked box indicates the channel is enabled for the film. If only two channels are available, then enabling a channel above 2 will have no effect.

Film Name	Tooling	Channel Enables <input type="checkbox"/> Crystal 1 <input type="checkbox"/> Crystal 2 <input type="checkbox"/> Crystal 3 <input type="checkbox"/> Crystal 4 <input type="checkbox"/> Crystal 5 <input type="checkbox"/> Crystal 6
Copper	100	
Material	Thickness Setpoint	
Copper	0	
Density	Final Thickness	
8.93	0	
Z Factor	Time Setpoint	Find Instrument
1	0 : 00	

To delete a film from the Films List:

1. Highlight the film to be deleted by clicking it once in the *Films* list box.
2. Click on the *Delete Film* button.

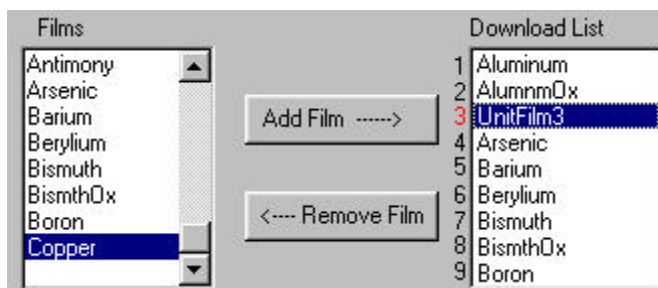


## 4.4 Download Films

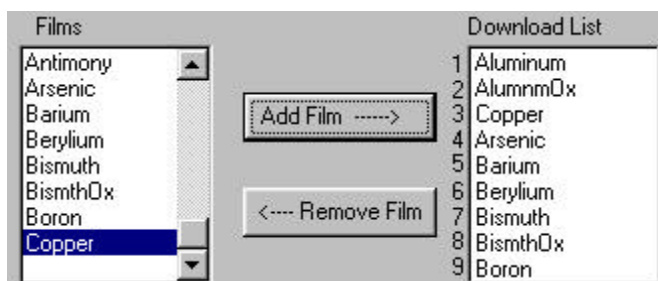
### To add or replace a film in the Download List:

1. Highlight the desired film by clicking on it in the *Films* list box.

2. Highlight the desired position for the film in the *Download List* box.



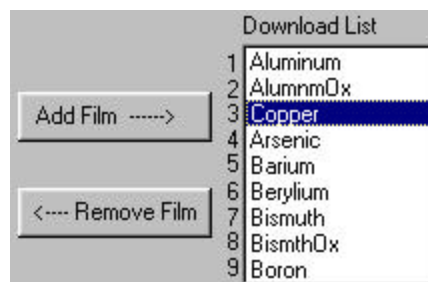
3. Click on the *Add Film* button. If there is already a film in the selected position in the *Download Films* box, it will be replaced with the new film. If there is no film in the selected position then the “UnitFilm#” will be replaced with the new film.



### To remove a film from the Download List :

1. Highlight the desired film by clicking on it in the *Download Films* list box.

2. Click on the *Remove Film* button. A “UnitFilm#” will be left in the list as a position holder.



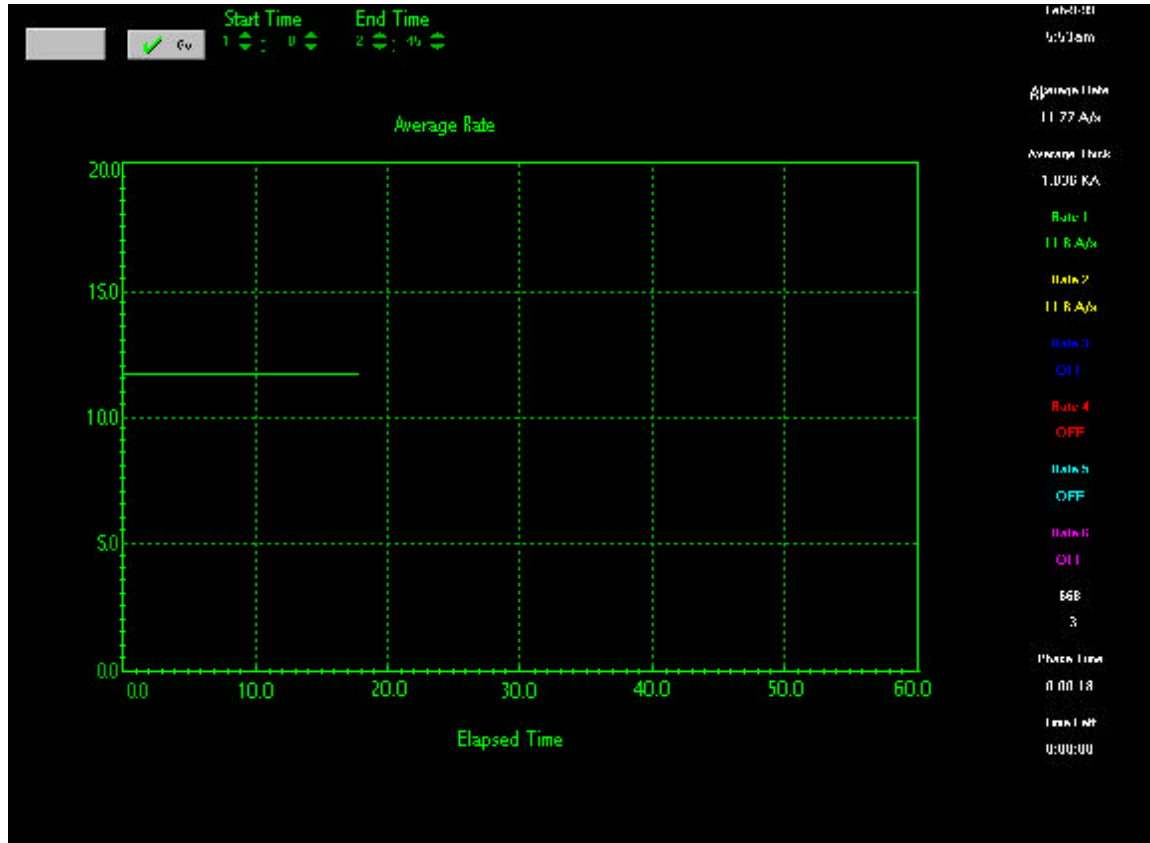
### To download the films in the Download List :

Click on the *Download Films* button. The films in the *Download List* box will be placed in the SQM-160 as Films 1 - 9 . A “UnitFilm#” in the *Download List* box indicates that the film in that position will not be affected by the download.



## 4.5 Graph Data

The SQM-160 graphs are accessed by clicking the *Graph* button.



Two graphs of data from the SQM-160 can be displayed. The first displays the average rate of all active channels versus time. The second graph displays each individual channel's rate versus time. To the right of the graph average rate, average thickness, each channel's rate, elapsed time, and estimated time remaining until final thickness are displayed.

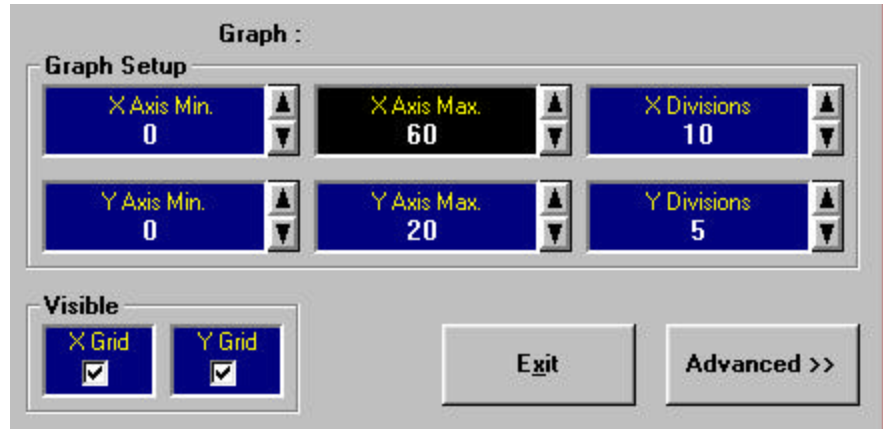
The display is changed from one graph to the other by clicking on the *Channel/Average* button in the upper left hand corner of the screen. The caption on the button is the graph that will appear if the button is clicked.

Graphing begins when the *Go* button is clicked. Graphing continues until the *Stop* button is clicked.

**To Adjust the Graph's Scope:**

1 Select the *Configure* menu followed by the *Graph* sub menu item to display the graphs configuration form.

2. Adjust the graph minimums and maximums as desired. The X and Y divisions determine the number of ticks between graph numerical markings and grid placement for each axis. The X and Y grids can be enabled or disabled with X and Y Grid check boxes.

**4.6 Save Data**

Your can save the data for Average Thickness, Average Rate, and each channel's Rate in an Excel format spreadsheet.

1. Click on the *File* menu followed by the *Newsb* menu.

2. Enter a name for the file in the Save In dialog box.

3. First set the starting time for the readings by adjusting the *Start Time* display to the desired minutes and seconds.



4. Next adjust the ending time for the window in the *End Time* display. The recording of the data will begin when the graph time reaches the *Start Time* and end when the graph reaches the *End Time* or the graphing is stopped.

## 4.7 Edit System Parameters

System Parameters are accessed by clicking on the *Config* menu item followed by the *System* sub menu. All of the system parameters, except Baud Rate, are available for edit.

Timebase 0.25	Rate Filter 8	Min Frequency 5.0
Simulate Mode <input checked="" type="radio"/> Off <input type="radio"/> On	Crystal 1 Tooling 100	Max Frequency 6.0
Freq Display <input checked="" type="radio"/> Off <input type="radio"/> On	Crystal 2 Tooling 100	Min Rate 0.0
Rate Resolution <input checked="" type="radio"/> Low <input type="radio"/> High	Crystal 3 Tooling 100	Max Rate 100.0
Etch Mode <input checked="" type="radio"/> Off <input type="radio"/> On	Crystal 4 Tooling 100	Min Thickness 0.000
	Crystal 5 Tooling 100	Max Thickness 1.000
	Crystal 6 Tooling 100	Update Parameters

The system parameters are downloaded to the SQM-160 by clicking on the *Update Parameters* button. The parameters can be reloaded into the form from the SQM-160 by clicking the *Refresh* menu item.

Return to the main display by clicking on the *Exit* menu item.

## 4.8 Load Defaults

The default film and system parameters can be loaded by clicking on the *Config* menu item followed by the *Load Defaults* sub menu item. The SQM-160 loads all default values into its parameters upon receipt of this command.

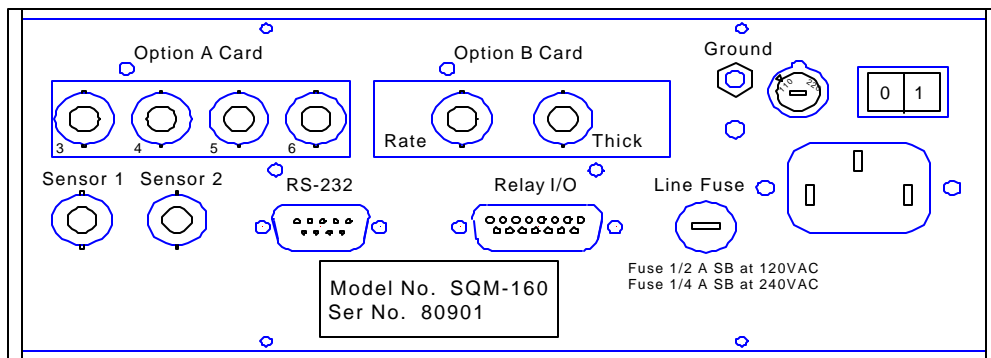
## 5.0 Introduction

**WARNING:** There are no user adjustments, or serviceable parts, inside the SQM-160. For maintenance or repair, contact

Sigma Instruments  
1318 Duff Drive  
Fort Collins, CO 80524 USA  
970-416-9660

## 5.1 Fuse Replacement

**⚡ WARNING:** Remove the power cable before replacing the fuse.



The SQM-160 is shipped with a 1/2 A Fuse for use with 90–120 VAC. If your line voltage is 180–240 VAC, replace the fuse with the 1/4A fuse included with your SQM-160.

**⚡ WARNING:** Always replace the Line Fuse with the same size and type fuse specified above.

## A. Material Parameters

Material	Density	ZFactor
Aluminum	2.73	1.08
Aluminum Oxide	3.97	1
Antimony	6.66	0.766
Arsenic	2.9	0.966
Barium	3.5	2.1
Beryllium	1.87	0.543
Bismuth	9.8	0.79
Bismuth Oxide	8.92	1.003
Boron	2.54	0.389
Cadmium	8.64	0.682
Cadmium Selenium	5.82	1
Cadmium Sulfide	4.83	1.02
Cadmium Telluride	5.85	0.98
Calcium	1.55	2.62
Calcium Fluoride	3.18	0.775
Carbon Diamond	3.52	0.22
Carbon Graphite	2.25	3.26
Cerium Fluoride	6.16	1
Cerium Oxide	7.13	1
Chromium	99.9	0.305
Chromium Oxide	5.21	1
Cobalt	8.71	0.343
Copper	8.93	1
Copper Sulfide	4.6	0.82
Copper Sulfide B	5.8	0.67
Copper Sulfide A	5.6	0.69
Dysprosium	8.54	0.6
Erbium	9.05	0.74
Gadolinium	7.89	0.67
Gallium	5.93	0.593
Gallium Arsenide	5.31	1.59
Germanium	5.35	0.516
Gold	99.9	1.111
Hafnium	13.1	0.36
Hafnium Oxide	9.63	1
Holmium	8.8	0.58
Indium	7.3	0.841
Indium Intimide	5.76	0.769
Indium Oxide	7.18	1
Iridium	22.4	0.129
Iron	7.86	0.349
Lanthanum	6.17	0.92
Lanthanum Fluoride	5.94	1
Lanthanum Oxide	6.51	1
Lead	11.3	1.13
Lead Sulfide	7.5	0.566
Lithium	0.53	5.9
Lithium Fluoride	2.64	0.774
Magnesium	1.74	1.61
Magnesium Fluoride	3	1

Material	Density	ZFactor
Manganese	7.2	0.377
Manganese Sulfide	3.99	0.94
Mercury	13.46	0.74
Molybdenum	10.2	0.257
Neodymium Fluoride	6.506	1
Neodymium Oxide	7.24	1
New	1	1
Nickel	8.91	0.331
Niobium	8.57	0.493
Niobium Oxide	4.47	1
Palladium	12	0.357
Platinum	21.4	0.245
Potassium Chloride	1.98	2.05
Rhenium	21.04	0.15
Rhodium	12.41	0.21
Samarium	7.54	0.89
Scandium	3	0.91
Selenium	4.82	0.864
Silicon	2.32	0.712
Silicon Dioxide	2.21	1.07
Silicon Oxide	2.13	0.87
Silver	10.5	0.529
Silver Bromide	6.48	1.18
Silver Chloride	5.56	1.32
Sodium	0.97	4.8
Sodium Chloride	2.17	1.57
Sulfur	2.07	2.29
Tantalum	16.6	0.262
Tantalum Oxide	8.2	0.3
Tellurium	6.25	0.9
Terbium	8.27	0.66
Thallium	11.85	1.55
Thorium Fluoride	6.32	1
Tin	7.3	0.724
Titanium	4.5	0.628
Titanium Oxide	4.9	1
Titanium Oxide IV	4.26	0.4
Tungsten	19.3	0.163
Tungsten Carbide	15.6	0.151
Uranium	18.7	0.508
Vanadium	5.96	0.53
Ytterbium	6.98	1.13
Yttrium	4.34	0.835
Yttrium Oxide	5.01	1
Zinc	7.04	0.514
Zinc Oxide	5.61	0.556
Zinc Selenide	5.26	0.722
Zinc Sulfide	4.09	0.775
Zirconium Oxide	5.6	1.001



## B. Specifications

### Measurement

Number of Sensors	2 standard, plus 4 optional
Frequency Range	4.0MHz to 6.0MHz
Frequency Accuracy	.01% @ 2 rdgs/sec.
Frequency Resolution	.1 Hz
Rate Accuracy	.5% typical
Rate Resolution	.01/.1 Å/s
Thickness Accuracy	.5% typical
Thickness Resolution	1 Å
Measurement Filter	1 to 20 readings
Measurement Period	.15 to 2 sec

### Film Parameters

Stored Films	9
Density	0.5 – 99.99 gm/cc
Tooling	10 – 399 %
Z-Factor	0.10 – 10.00
Final Thickness	0.000 – 99.99 kÅ
Thickness Setpoint	0.000 – 99.99 kÅ
Time Setpoint	0:00 – 99:59 sec

### System Parameters

Simulate Mode	On/Off
Frequency Mode	On/Off
Etch Mode	On/Off
Crystal Fail Minimum.	4.0 to 6.0 MHz
Crystal Fail Maximum	4.1 to 6.1 MHz
RS-232 Baud Rate	2.4/4.8/9.6/19.2 kb/s

### General Specifications

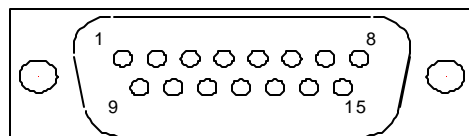
Power Supply	90-140VAC, 180-240VAC, 50-60HZ
Power Consumption	20VA
Operating Environment	0°C to 50°C
	0 to 80% RH non-condensing
Storage Environment	-40°C to 70°C
Operating Altitude	0 to 2,000 meters
Rack Dimensions (HxWxD)	88.5mm x 212.7mm x 196.9mm
Weight	13.2 kg (6 lbs)

### Accessories

Power Cord, Rack Mount Ears,  
Relay I/O Connector, RS-232 Cable,  
MonComm Software, Manual

## C. I/O Connections

A 15-pin female D-sub connector is included with the instrument to connect digital I/O to the SQM-160 Relay I/O connector. The figure below shows the solder side pin assignments for the connector.



**Relay I/O Connector Rear View**

Relays are rated for 125VAC or 30VDC, 2A maximum. Inputs can be activated either by connecting to a switch and shorting to Ground, or they can be driven by a TTL compatible signal. These are not isolated inputs! The voltage level applied must be limited to between 0 and +5 volts with respect to Ground.

Pins	Type	Description
1,2	Relay	Crystal Fail Relay, contacts closed when all enabled sensors have failed.
3,4	Relay	Timer Setpoint, contacts closed when timer reaches Zero from its programmed value.
5,6	Relay	Shutter Relay, contacts closed when shutter is open.
7,8	Relay	Thickness Setpoint Relay, contacts close when thickness value reached.
9	Input	Zero Timer Input, grounding this pin will zero the timer.
10	Input	Zero Thickness Input, grounding this pin will zero the thickness reading.
11	Input	Close Shutter Input, grounding this pin will close the shutter.
12	Input	Open Shutter Input, grounding this pin will open the shutter.
13,14,15	Ground	

## D. Declaration of Conformity

**Manufacturer's Name:** Sigma Instruments

**Manufacturer's Address:** 1318 Duff Drive  
Fort Collins, CO 80524 USA

**declares that the product:**

**Product Name:** Rate/Thickness Monitor

**Product Model:** SQM-160

**Product Options:** All Options

conforms to the following Product Specifications:

**Safety:** IEC  
CSA  
UL

**EMC:** CISPR  
IEC  
IEC  
IEC

Supplementary Information: This product complies with the requirements of the Low Voltage Directive 73 / 23 / EEC and the EMC Directive 89 / 336 / EEC (inclusive 93 / 68 / EEC) and carries the "CE" mark accordingly.

Fort Collins, Colorado

April 2000



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Gary L. Halcomb  
President